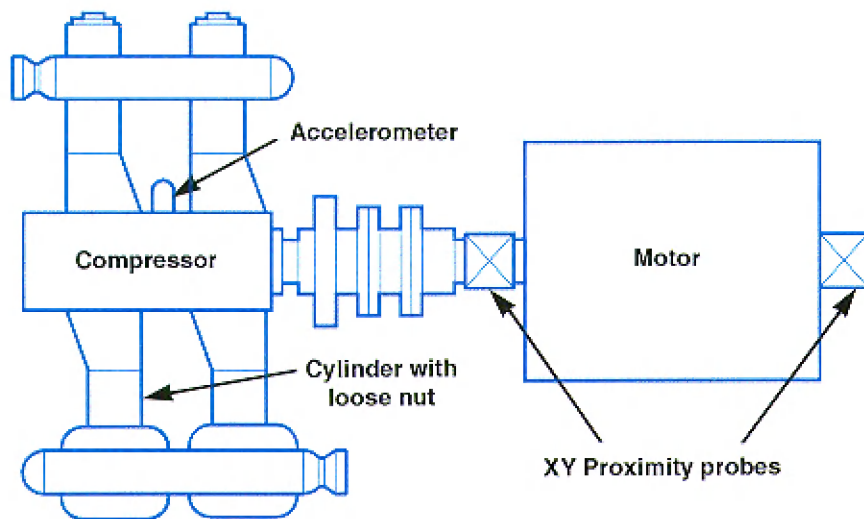




Detecting internal looseness in a reciprocating compressor



Machinery configuration diagram

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A Bently Nevada accelerometer system, installed on a reciprocating compressor, recently detected an internal looseness. The machine installation consists of a remotely-operated, 4-cylinder, reciprocating compressor driven by a 2000 hp electric motor, operating at 712 rpm. Since the machine operates at a fixed speed, the load is changed through unloaders which open and close suction valves on various cylinders.

A Bently Nevada 3300 Monitoring System monitors vibration on the compressor. Bently Nevada proximity probes are mounted 90 degrees apart in an XY configuration at the motor bear-

ings. A single Bently Nevada 23732 Accelerometer is mounted horizontally in the midspan of the compressor crankcase between two cylinder housings.

During normal operation, the compressor's acceleration amplitude was constant at approximately 3.5 to 4.0 g's. When the problem developed, the acceleration level increased to over 6 g's, which caused alarms to actuate in the remotely-located control room.

Problem analysis

Dow Chemical's vibration specialists were called in to help analyze and determine the extent of the problem. They quickly determined that the acceleration level changed from approximately 5.5 to 7.8 g's, depending on the load. This increase was unusual. An oscilloscope was connected to the buffered trans-

ducer output of the 3300 Dual Accelerometer Monitor. By observing the timebase waveform, plant personnel had a clear picture of what was being observed by the accelerometer.

Figures 1 to 3 show acceleration amplitudes at 50%, 75% and 100% load. Note the varying acceleration levels. Figures 1 and 2 indicate that at the end of each stroke of the piston, a hit occurred with an additional intermittent hit within the single cycle. At these loads, this intermittent hit was not consistent from cycle to cycle. At 100% load (Figure 3), when the acceleration increased to its maximum level of approximately 7.8 g's, the hitting became very dominant, along with the intermittent hitting which occurred halfway through the cycle. All of these patterns are very characteristic of a problem in the compressor, probably between the piston and the crankshaft. The compressor was shut down, so an internal inspection could be done to determine the source of the suspected problem.

Inspection

The inspection revealed a loose lock-nut on one of the piston rods. This lock-nut locks the piston to the piston rod; the nut is secured to a specified torque. The nut had loosened, allowing the piston to become loose on the piston rod. This was the source of the hitting that was seen on the oscilloscope. Fortunately, no damage had occurred. The nut was retorqued, along with other mechanical checks, and the compressor was put back in service.

Figure 4 shows the timebase waveform after the machine was repaired and at 100% load. A completely different pat-

tern is displayed, with no evidence of hitting or looseness. The acceleration also returned to normal levels of 3.5 to 4.0 g's.

It is interesting to note how the accelerometer was able to detect the looseness. If you look at the action on the timebase waveforms, you will notice a tremendous amount of high frequency noise. However, whenever there was an abnormal impact the effect is obvious.

Compare Figure 4 with Figures 1 to 3. The abnormal amplitude increases twice per shaft revolution. This indicates that there is a problem every time the piston changes direction.

Conclusion

This compressor was very effectively monitored by Bently Nevada monitoring systems, which saved the machine from substantial physical damage. In order for

a monitoring system to be effective, however, one must be knowledgeable of the construction of the monitored equipment. You must also be knowledgeable of the types of mechanical failures that can develop when the equipment is operated. This is true whether you are specifying vibration monitoring systems for reciprocating compressors or for other rotating equipment. ■

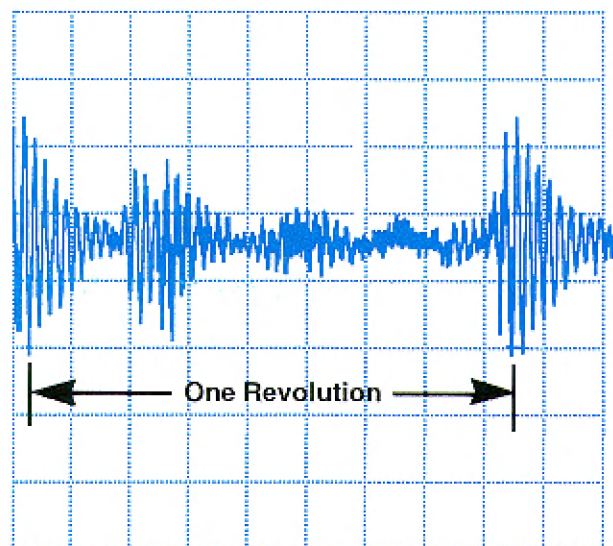


Figure 1:
50% of load. Acceleration level = 6.2 g

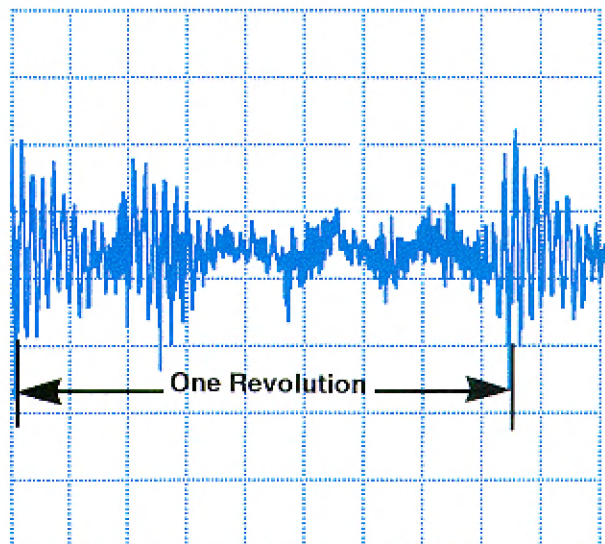


Figure 2:
75% of load. Acceleration level = 5.8 g

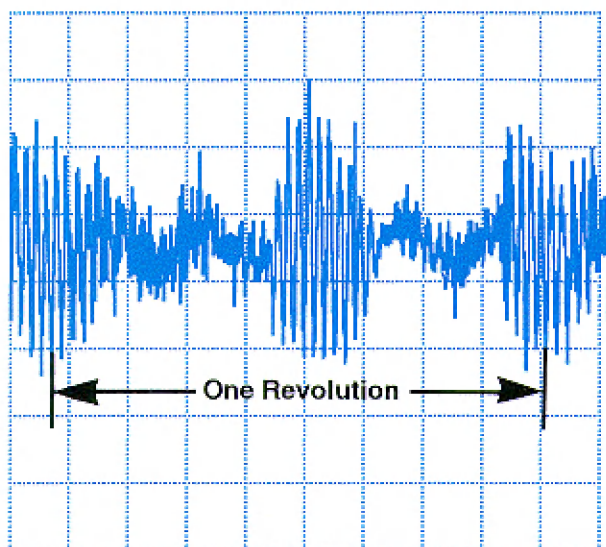


Figure 3:
100% of load. Acceleration level = 7.8 g

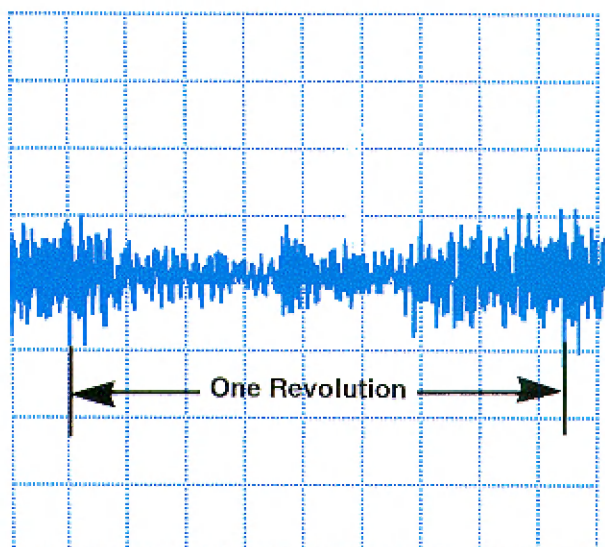


Figure 4:
After the machine repair. 100% of load. Acceleration level = 3.5 g.